PATENT

TITLE

Long Range and Ultralight Electric Vehicle

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LONG RANGE AND ULTRALIGHT ELECTRIC VEHICLE

Cross Reference to Related Documents

This application is related to a prior co-pending Disclosure Document of Joseph B. Kejha, Serial No. 383,278 filed October 16, 1995, entitled "Long Range and Ultralight Electric Vehicle." This application is also related to a prior co-pending Disclosure Document of Joseph B. Kejha, Serial No. 405,199 filed September 6, 1996, entitled "Circuitry for Individual Batteries Protection from Overcharge and Overdischarge." This application is also a continuation in part of the prior co-pending patent application of Joseph B. Kejha, Serial No. 08/373,090 filed January 17, 1995, entitled "Long Range and Safer Electric Vehicle Construction," which is related to a prior co-pending Disclosure Document of Joseph B. Kejha, Serial No. 322,973 filed January 12, 1993, entitled "Long Range and Safer Electric Vehicle Construction."

Background of the Invention

Field of the Invention

This invention pertains mostly to two wheeled and steered, long range and ultralight electric vehicle for at least one passenger, ~~which~~ is seated in a recumbent position, with substantially reduced frontal area, and having aerodynamically shaped front shield and body. The vehicle body is constructed from lightweight, impact resistant and energy absorbing materials. The vehicle has highly advanced non-polluting and economical propulsion and back-up power system.

Description of the Prior Art

Prior art two wheeled and steered electric vehicles are of similar construction as internal combustion engine driven motorcycles or scooters; that is to say that the driver was seated on a narrow uncomfortable seat in a high upright position, or in a leaning forward (head first) position, which causes high air drag, wrist fatigue and is dangerous in an accident. The ~~only difference is that the combustion engine with gas tank was replaced by an electric motor with batteries~~. Prior art electric scooters or motorcycles have body frame made from steel or aluminum, of various sections, welded together, and with fiberglass, plastic, or sheet metal panels attached to the frame. Vehicle construction which uses steel or glass fibers produces a body which is relatively heavy for use in an advanced electric vehicle. While aluminum metal is light-weight, it is not the most lightweight structural metal. Other fibers, such as carbon fibers, are brittle and dangerous in a crash, as they have low impact resistance, and aramid fibers are tough, but not the most lightweight fibers.

The prior art electric motorcycles or scooters often have high pressure air filled tires, which can blow out and cause accidents.

Prior art two wheeled electric vehicles have very limited ranges, not only because of their limited available space for batteries, their high body weight and high drag, but also because they utilize low specific energy density batteries.

Prior art two wheeled electric vehicles ~~have also~~ also have no protection ~~of~~ for batteries from overcharge or overdischarge when connected in series for high voltage, which shortens the ~~batteries~~ batteries life.

For electric vehicles, other than two-wheeled, an electric-hybrid construction has been proposed to increase the range, but the non-electric portion is not free from atmospheric pollution.

An engine which only reduces the atmospheric pollution and extends the range is proposed in U.S. patent of Dufour No. 4,031,865, which discloses a hydrogen generating cell used only as a supplement to a conventional gas fuel, such as gasoline, to improve the efficiency of the engine. Dufour fails to teach a non-polluting, hydrogen generating system which ~~is consuming~~ consumes only water, or only water and hydrogen.

U.S. patent No. 4,112,875 of Laumann et al. discloses a hydrogen-oxygen fueled, closed cycle internal combustion engine system in combination with solar cells, and which uses a pressurized noble gas, such as argon, as a working fluid, and which stores hydrogen and oxygen gases in storage devices under pressure, which is very dangerous, heavy and space demanding. Such a system would be too heavy, bulky and difficult to seal for use in a two wheeled vehicle.

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The low drag, ultralightweight, with high stored energy ~~highly energized~~, safer, non-polluting and long range two wheeled electric vehicle of the invention does not suffer from prior art problems and provides many positive advantages.

Summary of the Invention

It has now been found that long range, safer, non-polluting and ultralight electric vehicles for at least one passenger, and which ~~is~~ are riding on two wheels can be made as follows, by:

1. Seating the rider (passenger) in a recumbent or reclining position (feet first), on a wide and comfortable seat with back support and attaching the seat to a low, longitudinal, approximately horizontal frame beam, in adjustable manner, so that the rider's feet can reach the ground on both sides of ~~said~~ the frame beam. This configuration increases ~~the~~ safety in case of an accident, due to rider's closer distance to the ground and "feet first" position. It also substantially decreases the air drag of the vehicle and improves maneuvering, due to the low center of gravity. In addition, the wide seat protects the rider's hips and shoulders. During the ride, the rider's feet rest on a relatively small, fixed, but horizontally adjustable platform in front of the vehicle, and above and forward of a smaller front wheel, and the feet may ~~are~~ easily ~~removable to~~ reach the ground.

2. Providing an aerodynamic front shield, covering only the ~~feet~~ foot rest platform, feet, front steering and other selected components of the vehicle to further reduce air drag, but not to fully enclose the rider or to prevent his feet from easily reaching the ground.

3. Providing steering handle bars within easy reach and

in front of the reclining driver, with a vertical torsional tube connected to the front wheel fork; or an aircraft type steering handles ("horns" or "semiwheel") with an approximately horizontal torsional tube, connected with universal joints to an approximately vertical torsional rod or tube with a lever and push-pull rods of the front wheel lever and fork.

4. Providing two rear view mirrors which are wider than vehicle body, but are mounted to, and aerodynamically streamlined with the front shield, and are thus protecting the rider's hands.

5. Mounting an electric motor and preferably disc armature motor in low position behind the rider's seat, with preferrably timing belt reduction drive to a preferrably larger rear wheel, and positioning said rear wheel behind the seat.

6. Mounting batteries under the seat and protecting them from overcharge and overdischarge by charging them only individually in parallel to predetermined limits and discharging them together in series, but with individual disconnect, when discharged to predetermined limits.

7. Mounting a small internal combustion engine, with preferrably multiple generator for charging the batteries and for cruising, on a shelf above the rear wheel and behind the seat, or on the side of the rear wheel, and covering it with an aerodynamic cone cover.

8. Fueling said engine with non-polluting hydrogen gas, produced on demand only for safety, by electrolysis of water

carried in the vehicle, or stored in a metal hydride tank, or both.

9. Lowering the total weight of the vehicle and further increasing the safety by using magnesium metal, and preferrably magnesium alloy extrusions adhesively joined by various fittings, for vehicle body frame construction, and which frame supports and holds together all above described components, and by using ultrahigh molecular weight polyethylene fibers with a resin or ~~just~~ polyethylene sheets for the front shield and the rear cone cover construction, and by using lightweight pressure-airless tires.

10. Mounting the electrical control box preferably behind the seat.

In addition, it has been also found that some or all of the vehicle batteries can be replaced or supplemented by capacitors and/or a fuel cell system and preferrably by a water based fuel cell system.

The principal object of the invention is to provide a safer, steerable electric vehicle which can carry at least one passenger, which has two wheels, and has a low aerodynamic drag, is lightweight, has a low energy consumption and long range, while being non-polluting.

A further object of the invention is to provide a two wheeled electric vehicle which has a longer operating range than prior art two wheeled electric vehicles, due to its highly advanced propulsion systems.

A further object of the invention is to provide a two

wheeled electric vehicle which is easy and economical to manufacture.

A further object of the invention is to provide a two wheeled electric vehicle which has improved vehicle maneuvering and steering.

A further object of the invention is to provide a two wheeled electic vehicle which has long operating life.

A further object of the invention is to provide a two wheeled electric vehicle which is environmentally friendly and is constructed of recyclable materials.

Other objects and advantageous features of the invention will be apparent from the description and claims.

Brief Description of the Drawings

The nature and characteristic features of the invention will be more readily understood from the following descriptions taken in connection with the accompanying drawing forming part hereof in which:

Figure 1 is a side elevational and partly sectional view of the electric vehicle of the invention, illustrating various components of the vehicle, their locations, and positioning of the driver, ~~which~~ who is holding ~~an~~ aircraft-type steering handlebars, according to the subject invention;

Figure 2 is a top elevational and partly sectional view of the electric vehicle of the invention, according to the subject invention;

Figure 3 is a front plan view of the vehicle of the invention, illustrating the front aerodynamic shield with lights and protruding, streamlined rear view mirrors, according to the subject invention;

Figure 4 is a side elevational view of another embodiment of the electric vehicle of the invention, illustrating simplified front wheel steering, and a lower motor/generator unit mounting, as well as retractable side legs, according to the

subject invention;

Figure 5 is a side elevational view of another embodiment of the electric vehicle of the invention, illustrating an extended frame and configuration for ~~of~~ two passengers, according to the subject invention;

Figure 6 is a simplified schematic diagram illustrating the principle of the hydrogen fueled propulsion system, according to the subject invention;

Figure 7 is a simplified wiring schematic diagram illustrating the principle for ~~of~~ protecting the individual batteries of the electric vehicle of the invention from overcharge and overdischarge;

Figure 8 is a side elevational view of another alterned electric vehicle of the invention, showing a recumbent electric hybrid moped with front pedal drive, according to the subject invention;

Figure 9 is an axionometric view of the aircraft type handelbars and steering system of the electric vehicle of the invention;

Figure 10 is an axionometric view of the body frame and seat of the vehicle of the invention, showing a plurality of extrusions and various fittings joined by adhesive ~~and various fittings~~;

Figure 11 is an axionometric view of the welded body frame of the vehicle of the invention;

Figure 12 is a side sectional view of the front aerodynamic shield of the vehicle of the invention, showing the composite sandwich construction with honeycomb core;

Figure 13 is a side sectional view of the front aerodynamic shield of the vehicle of the invention, showing double-walled plastic construction;

Figure 14 is a side sectional view of the electric motor of the vehicle of the invention, taken approximately on line 14-14 of Figure 15, and illustrating a disc armature and magnets;

Figure 15 is a front view of the electric motor of the vehicle of the invention.

Like numerals refer to like parts throughout the several views and figures.

It should, of course, be understood that the description and ~~the~~ drawings herein are merely illustrative, and it will be apparent that various modifications, combinations and changes can be made of the structures and the systems disclosed without departing from the spirit of the invention and from the scope of the appended claims.

Description of the Preferred Embodiments

When referring to the preferred embodiments certain terminology will be utilized for the sake of clarity. Use of such terminology is intended to encompass not only the described embodiment, but also all technical equivalents which operate and function in substantially the same way to bring about the same ~~results~~ result.

The ~~light~~ light weight electric vehicle and for example one passenger electric vehicle comprises, a body which is usually riding on two wheels with a steering and braking system, a seat, an electric motor with a controller and a reduction drive connected to the rear wheel through a chain, a battery pack to store ~~the~~ electric energy, an instrumentation package and various lights.

The optional equipment may consist of an electric charger, a cooling system for ~~of~~ the electric motor and batteries, various electronic packages and an auxiliary internal combustion engine system with a generator.

The body may consist of a frame with the body panels attached to it. All above components may also be attached to said frame.

The preferred two wheeled electric vehicle construction of the invention was generally described in my prior disclosure documents Serial No. 383,278 and Serial No. 405,199 and in part Serial No. 322,973.

Referring now in more detail, ~~particularly~~ to the drawings ~~of this patent~~ and Figures 1, 2, and 3, one embodiment of the electric vehicle of the invention 1 has a body frame 2 with a front, steered wheel 3, and a rear, driven wheel 4. The driver 5 sits in a recumbent, wide seat 6 with back support 7, in a reclining position, similar to an automobile driver's position, and is lower to the ground level than a conventional motorcyclist, ~~and the~~ seat 6 is of ~~such~~ height, that the driver's feet can easily reach the ground on both sides of the frame 2. The seat 6 and support 7 protect driver's hips and shoulders. During the ride, the driver's legs are above the front wheel 3, and his feet rest on a small fixed platform 8, above and in front of the front wheel, and ~~said~~ platform is horizontally lengthwise adjustable telescopically to fit different drivers. The described seating arrangement lowers the center of gravity of the vehicle, makes the vehicle lower and safer, and more maneuverable, and makes ~~also~~ possible a very simple and lightweight, approximately horizontal beam 2A, with a rear wheel fork 9, mast 10, braces 11 and 11A attached to it, to form the body frame 2. The seat 6, front wheel fork 12, platform 8, and steering system 13 are also attached to ~~said~~ body frame. The steering handles 14 should be within easy reach of the driver 5, and may be part of an aircraft type "horns" or "semi-wheel" handlebars, which gives an automobile steering feeling to the driver. Handlebars of this type are attached to approximately horizontal or slightly inclined torsional element, such as rod

or tube 15, which is connected to an approximately vertical or slightly tilted torsional element 16, through at least one bellow or universal joint 17 and element 18. All this steering mechanism is supported by bearings or bushings embedded in a preferrably trapezoidal or triangular support structure 19. The vertical tube 16 may go through the horizontal frame 2, in front of the front wheel 3 and fork 12, and has attached thereto a lever 20 at the bottom and preferrably under the frame 2. One, or two push-pull rods 21 are attached preferrably through ball joint pins to the lever 20, and wheel connects it to a second lever 22, which is attached to the fork 12 of the wheel 3, also by pins. By rotating the handlebars similarly to a steering wheel in an automobile, the steering motion is transferred through the described torsional elements and universal joints to the bottom lever, and then through the push-pull rods to the second lever 22 of the front wheel fork 12, which fork is anchored in a bearing housing 23, which is attached to the frame 2. The front wheel fork 12 with the wheel 3 can rotate around it's approximately vertical axis, and this motion is controlled from handlebars by the above described mechanism. Motion of the lever 20 and thus the wheel 3 may be limited as desired by a preferrably adjustable stop block 24 in front of the tube 16 and lever 20. This steering system is also shown separately in Figure 9, which is another embodiment of the invention. The feet of the driver, as well as the feet rest platform 8, the steering mechanism and other selected components may be covered

by front, streamlined aerodynamic shield 25, which may ~~be~~ also be referred to as a "bubble" or "nose"; and possibly with a transparent windshield, or the shield itself may be transparent. The shield further reduces the air drag and should be attached to the horizontally adjustable ~~feet~~ foot rest platform 8. The shield may also cover or contain an electric motor controller 27, fuel tank 103, a battery 109, capacitors or fuel cells 114, instrument panel 28 and lights 29, 30, 30A, and two preferrably aerodynamically streamlined rear view mirrors 26, 26A, protruding on both sides of the shield 25 like "ears", as shown in Figure 3. ~~These ears~~ Mirrors may have a reinforced ~~and~~ strong structure, and structurally may be part of the shield 25 to protect the driver's hands in case of a side slip and fall.

Additional protection of the driver may be provided by a roll bar 39. Both wheels 3 and 4 may ~~have~~ also well known flexible suspension with shock absorbers (not shown).

The performance of the vehicle is also enhanced by reducing the body weight. The body weight reduction may be achieved by using substantially magnesium metal for body frame 2 and seat frame 6A construction, which may be constructed of extruded magnesium metal alloy tubings, such as tubings 2A and 202 to 213 inclusive, preferrably having square or rectangular sections, bonded together with an adhesive and the aid of various (preferrably magnesium) metal joint fittings 214 to 223 inclusive, as shown in Fig. 10; ~~and which~~ Fig. 10 is another embodiment of the invention, and ~~or said~~ frame and seat frame are

welded together, such as by weld 224, as shown in Fig. 11, and which is another embodiment of the invention. The fittings are understood to be structural elements for joining the ends of the tubes at their intersection points, by sliding into or over the tubings or may be threaded.

In addition, the wheels 3 and 4 are preferrably three spike wheels which may have also magnesium alloy hubs, spikes and rims.

It should be apparent to a person skilled in the art, that the body frame, seat frame and wheel construction, as described, is useable also in many other two wheeled electric vehicles.

A further weight reduction may be achieved by using ultrahigh molecular weight polyethylene fibers with a resin in a composite 225, or in a composite sandwich 226 construction, with paper, and preferrably a fire retardant paper honeycomb core 227, for the front shield 25 construction and for other body covers or panels construction, as shown in Fig. 12, which is another embodiment of the invention. The front shield and other covers may be referred to simply as "body panels" and should be attached to the body frame or components which they cover.

The front shield and other panels or covers may be also constructed from molded plastic, and preferrably lightweight polyethylene sheets 228 and 229, and are preferrably "double-walled" and welded, with a hollow space 230 therebetween, as shown in Fig. 13, which is another embodiment of the invention.

It ~~is~~ should be apparent to a person skilled in the art, that all the above weight and drag reductions contribute to a longer range ~~of said~~ vehicle, as compared to other prior art two wheeled electric vehicles, even ~~when having~~ with an identical prior art propulsion systems, equipment and payload.

Both materials, the magnesium and the ultrahigh molecular weight polyethylene with the honeycomb core composite sandwich construction, as well as the plain polyethylene double wall construction increase ~~the~~ safety, because they have the highest energy absorption and vibration damping characteristics of all known materials. This unique combination also contributes to a quiet ride of the vehicle. The fire retardant paper honeycomb may be made economically from recycled paper ~~economically~~, and the magnesium metal and polyethylene are also easily recyclable.

All described magnesium components may be protected from corrosion by well known design rules recommended for magnesium and by synergistic ~~fluoropolymer~~ Fluoropolymer coatings, such as made by General Magnaplate Corp., Linden, NJ., or anodic oxidation coatings, to overcome the low corrosion resistance of magnesium.

Sub C1 ~~The propulsion system comprises,~~ at least one electric motor 31 behind the seat 6, which may have preferably ~~preferrably~~ a copper disc clutch 200 (which may be controlled by the driver by well known means, and a reduction drive 32 preferably driving ~~preferrably~~ larger rear wheel 4 through a timing belt 33 and pulleys 33A ~~and 33B.~~ At least one battery or ~~batteries~~ 96 and 97 are preferrably mounted under the seat 6, or on both sides of the

rear wheel 4 (not shown), ~~very low~~ to keep the center of gravity of the vehicle low. The clutch 200 protects the motor and the batteries from an electric surge load during acceleration from standing or other shocks, and the copper material provides for long wear life. The electric motor may be controlled by a variable speed controller 27, attached to the ~~feet~~ foot rest platform 8, or it may be attached to the motor 31 (not shown), or to other components. ~~Accelerator~~ An accelerator which is electrically connected to the controller 27 may be a potentiometer 34 turned by a cable from a "wrist-twist" of the handle 14. There is no "shifting" of speeds involved. Other electrical components like electronic boards, relays, breakers, switches, fuses and distribution blocks (not shown) may be mounted in an electrical box 38, ~~preferrably~~ preferably behind the seat.

In addition to this "electric-only" drive, there is optionally provided at least one additional power system, comprising a small internal combustion engine 87, open to air as shown in Fig. 6, which may be a piston type reciprocating engine, rotary piston type, or a turbine, which is driving an electric current generator 104, which may be an alternator with a rectifier and voltage regulator for charging the batteries 96 and 97. The generator 104 may replace the engine flywheel to reduce the total weight, and may have a clutch 250 ~~enabling~~ to enable the engine to start without the generator load. This results in a smaller, lighter and less fuel consuming engine. The engine/generator unit may be mounted on a rack or shelf 35, behind the driver's seat 6 and above the rear wheel 4, and may be enclosed by an aerodynamic end cover

enclosure 37. The shelf 35 is supported by braces 36 and 36A. The aerodynamic end cover enclosure 37 may be also sound-proofed to reduce the engine noise. It is preferred to have the engine on the very end of the vehicle for the same reason, and because the engine is usually lighter than the generator. This additional power back-up system provides for an electric-hybrid vehicle and serves as a mileage extender, or as a main cruising power supply, with batteries used only for acceleration and extra power for hill climbing. The generator should be designed for cruising power, plus extra for charging ~~of~~ the batteries during a level cruising, and for other loads. However, it is possible to drive this vehicle a shorter distance only on battery power, as a "stealth" vehicle.

To make this engine or turbine non-polluting, it should be fueled preferably ~~preferrably~~ by hydrogen, contained in the tank 103, which tank may also contain a metal hydride of well known type. There is a great advantage in using an electric hybrid vehicle fueled by hydrogen, because the engine is approximately one third of the size required for a combustion-only driven vehicle. That means, the electric-hybrid has approximately three times longer range per the same amount of hydrogen. Because compressed hydrogen storage is very bulky and heavy, prior art hydrogen powered vehicles have very limited range, similar to electric-only vehicles. The electric-hybrid vehicle configuration fueled by hydrogen makes the hydro-electric vehicle of the invention competitive with gasoline fueled, combustion-only

vehicles, and is non-polluting. It should be noted that the negligible amounts of NO_2 generated can be captured by a catalytic converter 201.

Since the use of hydrogen as a fuel requires precautions, it may be produced for safety reasons on demand only, by electrolysis of water, which may be produced by action of the electric current generator 104, or the hydrogen may be produced by other sources.

If electrolysis of water is used, then the hydrogen tank 103 may be replaced (or assisted) by a hydrogen generating cell 105 of well known type, which may be electrically connected to the generator 104. ~~Said~~ The water may have also an antifreeze agent added.

The hydrogen generating cell 105 may ~~be~~ also be electrically connected to a battery 109, and/or to the batteries 96 and 97, to start the system operating and also for vehicle acceleration when the demand for fuel is high. The batteries may be recharged by the generator 104 during low power cruising or standing.

A simplified schematic illustrating the principles of the system is shown in Fig. 6, which is another embodiment of the invention. Switches or relays 110, 111, 112, 115 and 116 and valve 113 control the system functions as desired.

Referring now to Fig. 6 in more detail, the simplified operation of the system is as follows:

To start the engine 87 running, the switch 111 or switch

116 is turned "ON", which delivers direct electric current from the battery 109 or from the batteries 96 and 97 (if they still have some electric energy stored in them), to the hydrogen-oxygen generating cell 105, which produces hydrogen and oxygen gases and ~~said~~ the gases are delivered into the combustion chamber of the engine 87. The engine 87 is simultaneously being cranked either manually or by its own cranking battery with a starter (not shown). Because the hydrogen fuel and air, plus oxygen are being delivered into the engine, the engine starts runing and also driving the generator 104. When the switch 110 is turned "ON", the direct electric current from the generator 104 is delivered to the cell 105 and adds to, or replaces the current from the batteries 109 or 96 and 97. Then the switches 111 and/or 116 may be turned "OFF", which will disconnect the batteries from the cell 105.

If it is desired that the cell 105 is to be used to assist only ~~to the~~ for delivery of the fuel, then the engine 87 may be started as follows:

During cranking of the engine 87, all the switches shown are turned "OFF", but the valve 113 is opened, which delivers stored hydrogen fuel from the tank 103 into the combustion chamber of the engine 87 and the engine starts running and driving the generator 104. When the switch 110 is turned "ON", the electric current is delivered to the cell 105, which starts producing hydrogen and oxygen gases and ~~said~~ the gases are delivered into the engine 87, supplementing or replacing the

hydrogen fuel from the tank 103. Then the valve 113 may be closed. The batteries 109, 96, and 97 may be also recharged by the generator 104 when the switches 115 and 112 are turned "ON".

All the above described functions can be automated and controlled by an electronic controller (not shown) and all the switches may be replaced by relays.

All the "negative" or all the "positive" wires may be replaced by an electrically conductive frame or chassis.

All of the above propulsion systems preferrably use hydrogen as a fuel, but many other fuels are available, such as natural gas, propane, methane, or methanol.

It ~~is~~ should be obvious to a person skilled in the art, that the described hydrogen generating and ~~the~~ additional power generating system is useable also in many other two wheeled electric and/or electric hybrid vehicles.

While any suitable type of electric motor is useable, the preferred electric motor 31 or motors for ~~the~~ vehicles of the invention, are ~~the~~ disk armature design type motors, as manufactured by PMI Motion Technologies, Division of Kollmorgen Corporation, Commack, New York, U.S.A., and as shown in Fig. 14 and 15, which are ~~another~~ other embodiments of the invention. These motors may have neodymium iron boron magnets (Nd Fe B) 31A, as manufactured by SPS Technologies, Newtown, Pennsylvania, U.S.A., ~~and~~ a disk armature 31B, and may have also magnesium casings 31C.

Although the electric vehicles of the invention may use almost any type of rechargeable battery, the preferred batteries are lithium rechargeable batteries and more preferably, lithium-ion-polymer rechargeable batteries, or hydrogen based rechargeable batteries, as described in my patent application Serial No. 08/583,383.

The batteries and/or the engine/generator unit of the vehicle of the invention may be also replaced by at least one capacitor and/or by at least one electricity generating fuel cell system, which may replace at least one battery or all the batteries or the engine/generator in the described locations, or the vehicle may have an additional fuel cell system 114 to assist or charge the batteries.

The preferred fuel cell systems for the vehicles of the invention are the hydrogen/oxygen type, the hydrogen/air type and/or their combinations, but ~~more~~ the most preferred fuel cell system is the water based fuel cell system as described in my prior disclosure document of invention Serial No. 323,492, which water based fuel cell system is safe and economical.

The preferred tires for the electric vehicle of the invention are lightweight, pressure-airless tires with flexible honeycomb core as described in my prior U.S. ~~patent~~ patents #5,494,090 and #5,685,926. These tires are safer because they are puncture-proof and damage resistant and they also have low rolling resistance and thus further reduce the drag on the vehicle.

Because the batteries are usually the weakest components

in an electric-hybrid vehicle, at least as the useful cycle life is concerned, they should be protected from overdischarge and overcharge to extend their life. Prior art electric vehicles have unprotected batteries or cells connected only in series. Referring now to Fig. 7, ~~illustrating~~ which illustrates a simplified wiring schematic of the batteries protection of the vehicle of the invention, and the preferred components to accomplish it, ~~and~~ which is another embodiment of the invention. The simplified operation and description of the system is as follows:

For example, the vehicle 1 has two batteries 96 and 97 connected in series to supply ~~the~~ electric current to the 24 volt motor 31, through the motor controller 27, which receives a setting input from ~~potenciometer~~ potentiometer 34 and which is adjusted by the driver 5. This part of the system may be turned "ON" or "OFF" by the main switch 40. To recharge the batteries 96 and 97, the generator 104, driven by the engine 87, is provided. The generator 104 may be a multiple generator containing two 12 volt generators 104A and 104B preferrably on the same shaft, which are connected electrically in parallel to individual batteries 96 and 97, as shown. Each battery as shown has its own assigned and wired ~~as shown~~ monitoring and controlling unit (C.U.) 41 and 42, such as manufactured by PHOTRON, ~~Willitis~~ Willito, CA, ~~sensing~~ which senses individually each battery's energy level and voltage. For example, when battery 96 is fully charged to a predetermined and preset level, the control unit 41 will

disconnect the generator 104A from the battery 96 by relay 43, controlled by control unit 41. Similarly and independently, the battery 97 is protected from overcharge by control unit 42 with relay 44. In other ~~By another~~ words, the batteries are independently, individually charged in parallel and individually disconnected from charging when charged to predetermined and preset energy level or voltage, and thus protected from overcharge.

When batteries 96 and 97 are discharged together in series to deliver 24 volts to the motor 31, each battery energy level is again individually monitored by control and sensing units 41 and 42. If one of the two batteries reaches the predetermined and preset low (discharged) limit, that battery's control unit will disconnect the discharging circuit by relay 45 or 46.

Due to inevitable variation in individual batteries capacity, the "weaker" battery is discharged first, causing ~~causes~~ the load to disconnect and is thus protected from overdischarges, including the other "stronger" battery.

It is apparent, that this described circuitry can be expanded for any amount of batteries or cells in series, for any voltage system, and may have several low voltage generators (or alternators) preferrably on the same shaft, matching the voltage and quantity of the batteries or cells. Also, the multiple generators may be similarly replaced by multiple fuel cells, or multiple fuel cell stacks.

For example, lithium-ion batteries require protection of every 3.7 volt cell from overcharge or overdischarge, and also for

safety. The individual cells or batteries when discharged, may be also individually disconnected and by-passed, while the remaining cells or batteries continue to be discharged to preset limits. It is also apparent, that above described batteries protection is useable in many other electric vehicles and is applicable for any type of batteries.

Referring now to Fig. 4, which discloses another embodiment of the invention, an alternate two-wheeled electric vehicle 47 is illustrated, which may have a slightly modified frame 48, with simplified steering, ~~having~~ "T-bar" handlebars 49 and vertical torsional tube 50 connected directly to the front wheel fork 12.

The engine 87 with generator 104 in a cover 51 may be placed on one side of the rear wheel 4, lowering ~~thus~~ the center of gravity of the vehicle, and permitting the shelf 35 to be used for carrying baggage, or other components of the vehicle.

The vehicle 47 may also have two optional, lockable but retractable side legs 52 and 52A with very small wheels, to prevent the vehicle from falling during standing without the driver 5, or during standing, with the driver's feet on the platform 8. Deployment and retraction of the legs 52 and 52A may be fully automated by well known electromechanism, similar to landing gear of an airplane, and may be controlled by a switch mounted on handlebars 49. The legs 52 and 52A should not be wider than the mirrors 26 and 26A and should be retracted during

cruising.

The other features or components of the vehicle 47 may be indentical to those as shown for the electric vehicle 1, as described above.

Referring additionally to Fig. 5, another embodiment of the invention, two-passenger two wheeled electric vehicle 53 is illustrated, which has an extended and stronger body frame 54 with an additional seat 55, and which vehicle also carries ~~also~~ the second passenger 57. The feet of the second passenger 57 rest on two stands 56 and 56A, which are attached to both sides of the frame 54.

The vehicle may have ~~also~~ two additional batteries ~~59~~ 59A and 60A mounted on both sides of the rear wheel 4, and a windshield 58. The seat 55 of the first passenger 5 should be narrower with narrow back support, to accomodate the legs of the second passenger 57 and should have a holding bar 55A. The other features may be identical to the electric vehicle 1 or 47, as described above.

Referring to Fig. 8, another embodiment of the electric vehicle 59 is illustrated. The vehicle 59 is recumbent electric hybrid moped, having modified, lengthwise adjustable frame 60 to accept the front mounted pedals 61 and 61A with cranks and sprocket 62. The sprocket 62 ~~is driving~~ drives a sprocket 64 at the rear wheel 4 through a long chain 63, and ~~is assisting~~ assists ~~thus~~ the motor 31D during hill climbing, or during an exercise ride. The sprocket 64 and pulley 33B should have well known

overdrive clutches. The motor 31D, optional generator 104C with engine 87A and batteries 96A and 97A may be smaller and the frame 60 may be lighter than similar components in previously described vehicles 1, 47, and 53. The front shield may be omitted, or can be made larger to accomodate the pedals (not shown). The rear view mirrors 65 and 65A may be mounted directly on handlebars 49. All other features may remain as described above for vehicle 1 or vehicle 47.

The vehicle 59 may be also referred to as an electric double hybrid, since it utilizes human power together with engine/generator, or fuel cells to assist the batteries driving the electric motor and the wheel 4. The advantage of this configuration is in having ~~many times~~ a much longer range than electric bicycles with batteries-only power, and thus ~~providing~~ providing longer exercise time ~~to~~ for the rider, with more comfort and safety. This vehicle has ~~also~~ also a longer range per the same amount of hydrogen or other fuel ~~stored~~ stored, than the above described vehicles, and possibly 600 miles per gallon of an equivalent to gasoline.

It should, of course, be understood that the description and the drawings herein are merely illustrative and it will be apparent that various modifications, combinations and changes can be made of the structures and the systems disclosed without departing from the spirit of the invention and from the scope of the appended claims.

It will thus be seen that a long range and safer electric

vehicle construction has been provided with which the objects of the invention are achieved.